CHAPTER 7 PROPERTIES OF SOUND WAVES

Try This Activity: Vibrating Tuning Fork

(Page 237)

(a) When the tuning fork prong gently touches the surface of the water, the water is disturbed, usually causing splashing.
(b) The stationary pith ball bounces against the tuning fork prong when they touch.

7.1 WHAT IS SOUND?

Section 7.1 Questions

(Page 239)

Understanding Concepts

1. The dog whistle could be in the 15–20 Hz range (below human hearing) or over 20 000 Hz (above human hearing).

Making Connections

2. The fact that the sound of the gun can start an avalanche suggests that sound energy travels by waves. The energy from the gun is transmitted through the air by a large-amplitude sound wave that causes the avalanche. Warning signs in an avalanche-prone area would include no dynamiting, gunshots, or loud noises in this area.
3. (a) Since humans do not hear the sound, the frequency must be inaudible to the human ear. Thus, it must be lower than 20 Hz or greater than 20 kHz.
   (b) Answers may vary, but the frequency may not have been discovered earlier because the equipment was not sophisticated enough.

7.2 PRODUCTION AND TRANSMISSION OF SOUND ENERGY

PRACTICE

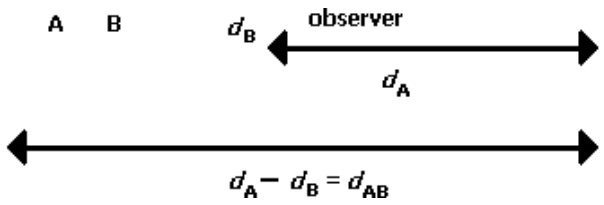
(Page 241)

Understanding Concepts

1. $v = f\lambda$
   $= (8.8 \times 10^{2}\ \text{Hz})(4.1 \times 10^{-1}\ \text{m})$
   $v = 3.6 \times 10^{2}\ \text{m/s}$
2. $f = \dfrac{v}{\lambda}$
   $= \dfrac{3.40 \times 10^{2}\ \text{m/s}}{1.7 \times 10^{-1}\ \text{m}}$
   $f = 2.0 \times 10^{3}\ \text{Hz}$
3. Compressions and rarefactions travel in the same direction — they follow one another.
4. Although pitch depends on frequency, three subjective characteristics of pitch are the perceptions of the observer, the complexity of the sound, and the loudness of the sound.

Applying Inquiry Skills

5.



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Procedure: Measure time between flashes (t_{AB}). Measure time between sound of lightning and flash at A (t_A). Measure time between sound of lightening and flash at B (t_B).
Use $d = v_s t$ to find d_A and d_B.
Calculate $d_A - d_B = d_{AB}$
Solve for v in $v = \frac{d_{AB}}{t_{AB}}$.

Section 7.2 Questions

(Page 242)

Understanding Concepts

1. (a) The strings or wires of a banjo vibrate.
   (b) The skin of the drum vibrates.
   (c) Vibrating air causes the sound in a whistle. The little ball that vibrates in the whistle helps produce turbulence of the air.
   (d) Rapidly expanding materials cause the sound in a crackling fire. For example, air pockets can pop, water can vaporize, and the wood can crack.
2. (a) True. The only way sound is produced is by vibrating objects.
   (b) False. Some vibrating objects have a frequency not in the audible range such as a dog whistle.
3. (a) $f = \frac{v}{\lambda}$
   $= \frac{340 \text{ m/s}}{1.13 \text{ m}}$
   $f = 301 \text{ Hz}$
   (b) $f = \frac{340 \text{ m/s}}{0.695 \text{ m}}$
   $f = 489 \text{ Hz}$
4. $\lambda = \frac{v}{f}$
   $= \frac{350 \text{ m/s}}{50.0 \text{ Hz}}$
   $\lambda = 7.0 \text{ m}$
5. $v = f\lambda$
   $= (260 \text{ Hz})(1.30 \text{ m})$
   $v = 338 \text{ m/s}$
6. $\Delta d = v\Delta t$
   $= (330 \text{ m/s})(3.0 \text{ s})$
   $\Delta d = 990 \text{ m}$ or $9.9 \times 10^2 \text{ m}$
7. The energy from the explosion is transmitted through the air by a large-amplitude sound wave that shatters the windows.

Reflecting

10. Evidence that sound waves exist include:
    - sound from a vibrating string or loud speaker stimulates the ear drum
    - the sound from a passing truck can cause objects to vibrate in resonance
    - the movement of a speaker cone
    - a dog responding to a dog whistle

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